MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

ECP3086 – MULTIMEDIA TECHNOLOGY AND APPLICATIONS

(RE)

14 JULY 2023
9.00A.M – 11.00A.M
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 5 pages excluding the cover page.
2. Answer **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the answer booklet provided.

QUESTION 1 [25 MARKS]

a) Explain **TWO** important features of continuous media. Give **ONE** example of continuous and non-interactive media.

[3 marks]

b) Write HTML code to create a webpage as shown in Figure Q1.

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Figure Q1

[8 marks]

c) Given the following alphabets with their probabilities shown in Table Q1.

Table Q1

A	B	C	D
1/4	1/8	1/2	1/8

(i) Calculate the entropy, H in bits.

[3 marks]

(ii) Why are fixed length codes inefficient for alphabets whose letters are not equiprobable? Discuss this in relation to Morse Code.

[4 marks]

(iii) Provide an example of a uniquely decodable prefix code for the above alphabet which is optimally efficient. What features make it a uniquely decodable prefix code?

[4 marks]

(iv) Determine the coding rate. Justify whether it is optimally efficient.

[3 marks]

Continued...

QUESTION 2 [25 MARKS]

a) Subtractive colour mixing is based on reflective colours rather than emissive colours. To print red colour from CMYK colour scheme, determine which colours should be subtracted.

Hint: $\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix}$

[4 marks]

b) Figure Q2(a) shows a DCT coefficient matrix that will be quantized by an 8x8 quantization matrix as given in Figure Q2(b).

DCT Coefficient Matrix

515	65	-12	4	1	2	-8	5
-90	4	2	0	0	-9	-11	3
-12	6	22	-1	3	0	1	2
0	-2	7	-5	4	0	-1	-4
0	-3	-1	0	4	1	-1	0
3	-2	-3	3	3	1	1	-3
3	-2	-3	3	3	-1	-1	-3
-2	5	-2	4	-2	2	-3	0

Figure Q2(a)

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
50	78	78	87	103	121	120	101
73	92	95	98	112	100	103	99

Figure Q2(b)

(i) Find the quantized DCT coefficient matrix and obtain the Run-Length Coding (RLC) output for the AC coefficient after zig-zag scanning.

[6 marks]

(ii) Justify whether the above method is lossy or lossless.

[2 marks]

c) Given the DC coefficient of the first 6 image blocks as 312, 320, 308, 315, 309 and 310. Construct DPCM-coded DC coefficient represented by a pair of symbols (size, amplitude), where size represents the number of bits needed for the coefficient while amplitude contains the actual bits.

[5 marks]

Continued...

d) JPEG2000 uses Embedded Block Coding with Optimized Truncation (EBCOT) as its primary coding method. Discuss how the EBCOT algorithm improves the quality, resolution scalability and random access of an image.

[8 marks]

QUESTION 3 [25 MARKS]

a) Dynamic range is the ratio of maximum to minimum absolute values of the signal (in dB) as shown below.

$$DR = 20\log_{10}\frac{V_{max}}{V_{min}}$$

V_{min} equals to quantization step-size, given by

$$\Delta V = \frac{V_{max}}{2^{N-1}}$$

Consider the dynamic range of a signal is 50dB and the required quantization noise is at least 20 times smaller than *Vmin*. Determine whether 16 bits or 12 bits (bit depth) are sufficient for your system design. Justify.

[5 marks]

b) Audio signal digitization involves sampling, quantization and encoding.

(i) By changing the digitization parameter, propose **TWO** methods that can be used to reduce quantization noise.

[2 marks]

(ii) Compare linear and nonlinear quantization.

[4 marks]

(iii)Discuss the advantage of nonlinear quantization scheme such as the μ-law quantization for speech coding.

[4 marks]

c) Figure Q3 shows the masking curves of several frequencies for a sound level of 60dB which affects the threshold of human hearing.

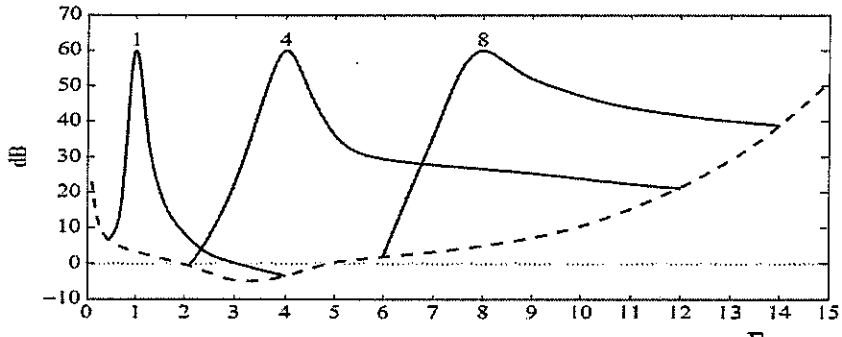

Figure Q3

Continued...

Consider the following sound levels:

- 20dB at 7kHz
- 40dB at 10kHz

For the two sounds levels above, analyse whether the sounds above are audible for the following conditions:

(i) Threshold of human hearing
(ii) The 1kHz frequency masking curve
(iii) The 4kHz frequency masking curve
(iv) The 8kHz frequency masking curve

Based on the result, suggest a strategy to allocate the number of bits for the tones to reduce quantized data size.

[10 marks]

QUESTION 4 [25 MARKS]

a) Briefly compare inter-pixel spatial redundancy and inter-pixel temporal redundancy.
[4 marks]

b) Figure Q4 shows the 4:4:4 and 4:2:2 colour sub-sampling format used in video coding. The colour scheme used is YUV.

4:4:4 4:2:2

Figure Q4

(i) Explain the purpose of colour sub-sampling in digital video.
[2 marks]

(ii) Discuss the difference between 4:4:4 and 4:2:2 colour sub-sampling format.
[2 marks]

(iii) Consider the video resolution is 350x240 active pixels, frame rate is 30fps, and 4:2:0 colour sub-sampling format is used for each Y, U and V component, calculate the data rate (in kilobits/sec) for the encoded video stream.
[3 marks]

(iv) Why is YUV colour scheme used in video transmission rather than RGB colour format?
[2 marks]

Continued...

c) Explain the function of the following key components of a video conferencing terminal.

(i) Audio/video processing

(ii) Multiplex/demultiplex and synchronization

[4 marks]

d) A content-based image retrieval (CBIR) system using query by example is to be evaluated. Table Q4 shows the images in the database and its Tamura texture feature vector. Consider the user uses the query image "im.jpg" and obtains its Tamura texture feature vector f^Q = [0.1 0.3 0.3 0.3 0.8 0.9]. The user is searching for the two most similar images to the query image among the five images in the database. Identify the two most similar images that are retrieved from the database. Use the following table as your guide.

Table Q4

i	Image	Tamura texture feature vector, $f^Q{}_i$	Euclidian distance between feature vector of query image and database image, D(fQ , fDi)
1	1.jpg	[0.1 0.8 0.2 0.2 0.1 0.9]	
2	2.jpg	[0.1 0.2 0.3 0.1 0.9 0.9]	
3	3.jpg	[0.7 0.2 0.3 0.1 0.1 0.1]	
4	4.jpg	[0.5 0.5 0.3 0.1 0.6 0.4]	
5	5.jpg	[0.6 0.1 0.2 0.5 0.5 0.1]	

[8 marks]

End of Page